



Science &
Technology



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The U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T) Chemical Security Analysis Center (CSAC) is the Nation's only federal studies, analysis, and knowledge management center for assessing critical chemical dependencies, emerging threats and technologies, and accidental or intentional chemical events in the United States.

CSAC accomplishes its mission by:



Acquiring and managing reliable chemical data for all stakeholders



Generating meaningful assessments, recommendations, and forecasts based on vetted data



Identifying, prioritizing, and addressing data gaps through high quality chemical research, development, test, and evaluation



Researching current and emerging threats and technologies

CSAC is highly sought after for its role in serving the Homeland Security Enterprise and its stakeholders with chemical subject matter expertise. CSAC staffs and operates a 24/7 Technical Assistance program that provides operational support, designs and executes laboratory and field tests, and maintains a comprehensive knowledge repository of chemical threat information that is synthesized and updated with data from scientific, operational, and private-sector sources.

CSAC IN DEMAND

CSAC Developed Scenarios for the 2024 NCAA Division I Men's Basketball Tournament 'Final Four'

In 2023, CSAC briefed emergency and response planning teams in Phoenix and Glendale, Arizona in advance of Super Bowl LVII. As a result of the valuable insights CSAC provided, the planning teams invited CSAC to participate in the preparation for the 2024 National Collegiate Athletic Association (NCAA) Men's Final Four basketball tournament and auxiliary events. For 2024, CSAC developed scenarios spanning multiple indoor and outdoor venues using different toxic industrial chemicals and chemical warfare agents that could be executed by adversaries with a range of capability levels. CSAC briefed the results to the emergency response planning teams and DHS Cybersecurity and Infrastructure Security Agency personnel. Participants gained a better understanding of chemical threats, the extent of casualties possible, and the benefits and limitations of the available medical countermeasures in the event of a chemical attack at a crowded event. The Glendale and Phoenix planners recommended CSAC to San Antonio emergency responders to assist with planning for the 2025 NCAA Men's Final Four. CSAC is currently working with San Antonio teams to understand their needs and priorities.



"Excellent briefing by CSAC and my thanks to all for working to keep our events safe."

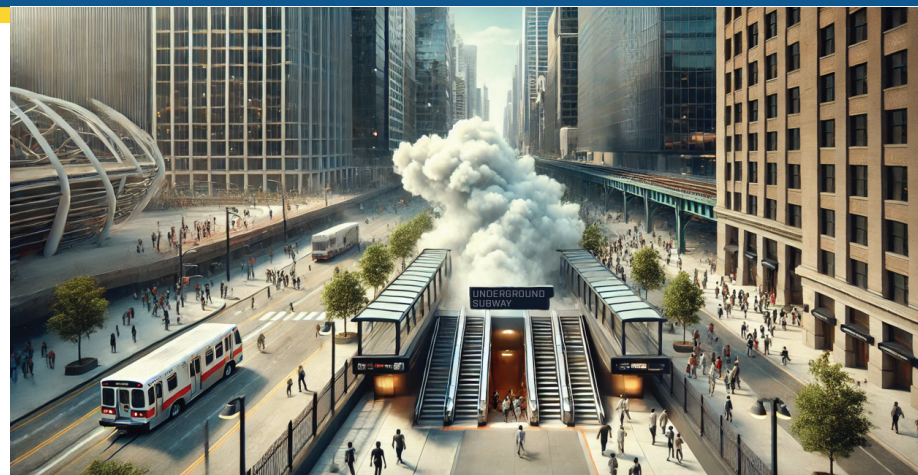
- Matthew Crymble, Cybersecurity and Infrastructure Security Agency

CSAC Enhanced the Chemical Aerosol Standoff Distance Tool (CASDT)

CSAC developed the CASDT for the United States Secret Service in 2022. In 2024, CSAC conducted a literature review and identified enhancements for inclusion in the tool, including two types of chemical hazard release mechanisms, namely fireworks and stationary unmanned aerial vehicles. CSAC also evaluated the removal of airborne material using half- and full-face respirators, and how crowd configuration and density can affect downwind airflow and dispersion of a chemical release.

CSAC Assisted in Transitioning the Urban Model Integration (UMI) Tool

CSAC performed functionality testing and guided the development of a user manual and software documentation for the “Tri-lab” Urban Modeling software tools developed by Los Alamos, Sandia, and Argonne National Laboratories. These tools included the Rapid Plume Viewer, Sensor Siting Tool, the UMI Program web-based application, the World Trade Center Complex Viewer, and the Detector Siting Cross-Domain Optimization Tool. CSAC’s engagement enabled the transition of the UMI toolset to the DHS S&T system.



An AI-generated image by CSAC depicting a “chemical release in an urban area with a subway system”.

CSAC Committed to Nurturing Next-Gen Chemical Professionals

For the summer of 2024, CSAC selected and hosted six student interns from universities across the country using the Homeland Security Professional Opportunities for the Student Workforce to Experience Research (HS-POWER) internship program. CSAC also hosted two junior and senior high school teachers through the Army Education and Outreach Program Research Experiences for Science Technology Engineering and Mathematics (STEM) Educators and Teachers. The work assigned to the interns and teachers directly contributed to real-world projects aimed at evaluating and protecting against chemical threats, enhancing the accuracy of chemical threat detection, and repurposing existing methodologies to innovate new tools tailored for first responder missions. The rigorous training and project involvement not only augmented the interns' technical capabilities but also equipped them with essential skills in problem-solving and teamwork. These competencies are crucial for their future STEM careers.

In addition, 12 Homeland Security interns visited CSAC for a one-day historical tour of the Edgewood area of Aberdeen Proving Ground where CSAC's facilities are located. The interns represented the S&T Office of National Laboratories (ONL), International Cooperative Programs Office, and Transportation Security Laboratory, and gave short presentations on each of their summer projects. This event provided an opportunity for interns to meet their S&T counterparts in person and facilitated discussions on end-of-year projects to be presented to the Office of University Programs (OUP). OUP administers the HS-POWER internship program, which is a key outreach and workforce development platform available to DHS through S&T. CSAC's Deputy Director, Helen Mearns, expressed how incredible it was to see the next generation of talent engaging with one another and with CSAC and hopes to see the group working for S&T again in the future.



CSAC hosts HS-POWER interns from across DHS in July 2024.

CSAC Supported Water Defense Workshop

CSAC participated in the Federal Bureau of Investigation's (FBI) Water Defense Workshop and provided a presentation titled "Terrorism Risk Assessment Modeling of Chemical Threats to Municipal Water Distribution Systems." As the lead agency for chemical threats and the developer of the water contamination model, CSAC is a key partner in assisting the FBI in sharing these chemical vulnerabilities with state, local, tribal, and territorial (SLTT) partners. CSAC presented and demonstrated the Municipal Water Model and highlighted

potential risks and hazards for the water community, showcasing the capabilities CSAC provides to the FBI and water sector municipalities. Based on continued requests by the FBI, CSAC has supported this workshop at other regional events and shares information to enable the water industry work to eliminate and mitigate risks in the water and wastewater sectors from intentional contamination. This work helps to save lives and protect the integrity of critical U.S. infrastructure.



Digital collage representing CISR workshop. Image by Freepik.

CSAC Provided Expertise at Critical Infrastructure Security & Resilience (CISR) Workshop

CSAC was invited to speak at the CISR university's programs development workshop. The workshop aimed to equip international participants with knowledge and best practices in chemical-related critical infrastructure protection, fostering a robust and sustainable CISR posture. CSAC provided an overview of ONL's work and CSAC's efforts in chemical prioritization and risk analysis for chemical

facilities. CSAC's presentation also covered its Jack Rabbit program, which focuses on designing and executing large-scale release studies of chlorine and ammonia to analyze and understand their operational impact. One area of particular interest to participants was CSAC's Chemical Agents Reactions Database (CARD). CSAC looks forward to more opportunities to highlight best practices for protecting chemical-related critical infrastructure to ensure the safety and resilience of the Homeland.

CSAC Hosted Interagency Visits

In October 2023, CSAC hosted the DHS Under Secretary for Science and Technology (USST), Dr. Dimitri Kusnezov, for a half-day visit, providing an overview of CSAC's capabilities and efforts. The visit was a valuable opportunity to highlight project areas and demonstrate key focus areas such as the Countermeasure Assessment and Planning Tool (CAPT Web) capabilities, the Non-Traditional Agents (NTA) Library, rapid cyanide detection (RAPCYD), the Jack Rabbit program, Chemical Hazard Characterization (CHC), and the electronic nose (E-nose) detection project. Dr. Kusnezov was introduced to U.S. Army Combat Capabilities Development Command Chemical Biological Center (DEVCOM CBC) leadership who stressed their mutually beneficial relationship with CSAC, particularly regarding the shared Chemical Security Laboratory (CSL).

In January, over 30 personnel from across S&T and DHS visited CSAC. The visit included a tour of CSAC's CSL with demonstrations of E-nose sensor technology and an overview of CSAC's RAPCYD innovation and organoleptic testing. Attendees had the opportunity to build a scenario in the Chemical Consequence and Threat Tool, part of S&T's All Hazards CAPT Web, and the Homeland Explosive Consequence Assessment Tool. CSAC subject matter experts were on-hand for interactive discussions on Jack Rabbit, the CARD, and the NTA Library. Emphasizing the unique relationship between CSAC and DEVCOM CBC, the visit also included briefings by DEVCOM CBC subject matter experts on capabilities in BioTech and Chemical and Biological Detection and Characterization. Participants were provided the opportunity to tour DEVCOM CBC's Advanced Chemistry Laboratory, a unique facility designed for working with

the most toxic chemical compounds in existence.

In March, Assistant Secretary Mary Ellen Callahan of DHS's Office of Countering Weapons of Mass Destruction (CWMD) Office visited CSAC to be briefed on the laboratory's



CSAC hosted over 30 personnel from across S&T and DHS.

mission, capabilities, and activities in domestic chemical security. On the tour, laboratory staff demonstrated CSAC's active chemical threat characterization and innovation initiatives for the Assistant Secretary and other guests. One topic of interest was the landscape



CSAC hosted CWMD, left, and the EPA CMAT.

of Artificial Intelligence (AI) in the field of chemistry and what risks need greater awareness. As a result, the Assistant Secretary provided CSAC with the draft report "Reducing the Risk at the Intersection of AI and CBRN Threats" to review and provide feedback. Current collaborations between CWMD and CSAC were also discussed, including Fourth Generation Agents (FGAs), Gas-Forming Reactions, and Chemical Forensics.

Throughout April, CSAC hosted S&T Budget Director Jason Parker and the Office of Management and Budget Program Examiner Lamar Robinson, legislative staff representing Minority and Majority members of the Senate Appropriations Committee, and DHS' Deputy USST, Julie Brewer. These in-person visits highlighted the



importance of CSAC's mission and the criticality of its work to DHS and its partners. CSAC provided an overview of the chemical threat landscape, the lab's capabilities and tools, as well as its projects, research, and impacts. Several demonstrations of

current and ongoing research capabilities were provided, including the use of CAPT Web in developing tailored chemical threat analysis and assessments, the CARD, and the NTA Library. On a tour in the CSL, CSAC introduced the RAPCYD capability and patent, CHC, and E-nose detection. Guests were impressed and departed with firsthand knowledge of CSAC.

In August, CSAC hosted staff from the U.S. Environmental Protection Agency's (EPA) Chemical, Biological, Radiological, and Nuclear (CBRN) Consequence Management Advisory Team (CMAT) and provided a similar overview of CSAC, its capabilities and tools, and a tour of the facilities.

CSAC Delivered Impactful Chemical Threat Information to the Intelligence Community

CSAC implemented a new system of classified analysis and organization of intelligence that has substantially expanded the ability to track and respond to emerging chemical threats. This innovative system and architecture is stored on a classified network to track, categorize, and collect intelligence reporting in key chemical subjects and categories. CSAC can spotlight highly impactful chemical threat information with a “CSAC” tag and provide key subject matter expertise and insights to the reporting through added notes and commentary that is visible to the entire intelligence community.

Deployment of this system resulted in multiple outside agencies adopting and utilizing it as well. This led to a new partnership with the

U.S. Department of Commerce to track national security threats to the chemical supply chain and strategic chemicals. Moreover, engagement with CWMD on chemical threats shows consistent growth. This enhanced interagency coordination will have significant impacts on national security.



An AI-generated image by CSAC illustrating “organization of chemical threat intelligence”.

In addition, CSAC developed strategic knowledge products on opioids for the intelligence community. Along with a leading technical role in an international mail facility analysis with Customs and Border Protection in the DHS S&T Synthetic Opioid Detection at Speed program, the following resources were developed for detection and interdiction of illicit opioids:

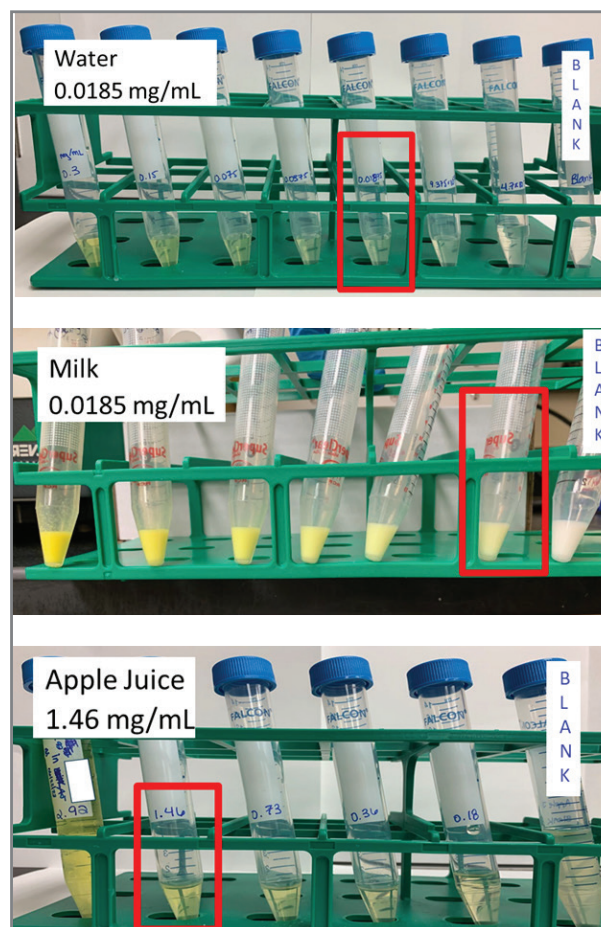
- Fentanyl Synthesis Quick Reference Guide
- Nitazene Benzimidazole Opioid Synthesis Quick Reference Guide
- Memorandum for Record 2.0: Illicit Drug Threats
- Nitazene Synthesis and Reagents Bulletin
- Master Question List for Synthetic Opioids
- Memorandum for Record 2.1: Illicit Drug Threats

CSAC CSL Support

CSAC's laboratory work experimentally determines chemical and physical properties of chemicals of interest to fill data gaps, and inform the safety of food for the U.S. public.

CSAC produces and publishes comprehensive technical notes on the aqueous solubility of chemicals using orthogonal detection systems. These documents serve as foundational resources for understanding chemical behavior in water, which is crucial for accurately assessing risks associated with chemical spills or intentional contamination.

Building on initial studies, the CSL extended its research to include food matrices such as vinegar, apple juice, vegetable oil, and alkaline water. This expansion is crucial for supporting the food defense mission, as it allows for a broader assessment of how chemicals interact with different substances, potentially impacting food safety and public health.



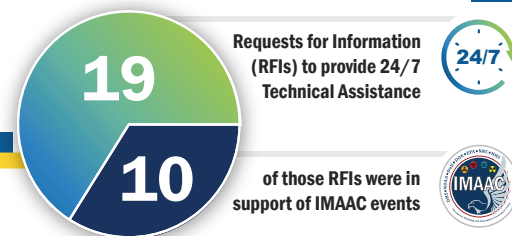
Organoleptic determinations for 2,4-dinitrophenol. Red box denotes concentration where it would be detected.

CSAC conducts significant food defense efforts and subject matter experts meet regularly to share information and provide expert guidance to the U.S. Department of Agriculture, Food and Drug Administration, DHS Food and Agriculture Sector Risk Analytical Capabilities, Food and Agriculture Sector Coordinating Council / Government Coordinating Council, and other food defense consortiums. Food defense and modeling efforts ensure CSAC is informed on the latest food threats and defense initiatives that help strengthen the Nation's health security.

CSAC Senior Scientist and subject matter expert, Dr. Carol Brevett, was the lead author of a publication in the Journal of Food Protection about the intentional adulteration of foods with chemicals.

CSAC Provided Chemical Facility Analysis During the 2024 Atlantic Hurricane Season

CSAC provides chemical hazard and vulnerability information to inform SLTT responders during the annual hurricane season. Through September 2024, the Atlantic Hurricane Season included 10 named storms and resulted in four hurricanes making U.S. landfall. Hurricane Beryl made landfall near Matagorda, Texas, as a Category 1 hurricane. Hurricane Debby made an initial landfall near Steinhatchee, Florida, and a second landfall in Charleston, South Carolina. Hurricane Francine made landfall in Terrebonne Parish, Louisiana, as a Category 2 hurricane, and Hurricane Helene made landfall in the Big Bend area of Florida as a Category 4 hurricane. CSAC identified the chemical facilities and infrastructure that store, produce, or transport large quantities of hazardous chemicals that were in the projected paths of the storms.



CSAC Provided Chemical Facility Monitoring for Smokehouse Creek Fire

CSAC monitored the location of fires as they related to chemical facilities, power plants, oil fields, and other important facilities. The Smokehouse Creek Fire came close to the Pantex Nuclear Weapons facility in Texas and shut it down for one day. The wildfire was brought under control before reaching the facility, and they resumed work the next day.

"I called in the request last night as I was going out the door. Thanks for your rapid and thorough response. It is a pleasure having you in on the mission."

– Kradak Thomas, PhD, Defense Threat Reduction Agency

CSAC Provided Chemical Monitoring for Industrial Fire

CSAC collaborates closely with the Interagency Modeling and Atmospheric Assessment Center (IMAAC) and Defense Threat Reduction Agency as part of CSAC's 24/7 scientific support and technical assistance services. In September, a fire broke out on the roof of a plant in Georgia that manufactures pool and spa treatment products. The fire triggered the plant's sprinkler system, causing water to mix with a chemical and creating a large plume of smoke and airborne chemicals. CSAC provided a comprehensive list of facilities and chemicals present within a 50-mile boundary, so they could safely evacuate or shelter people in place. As a result, the incident saw zero injuries while 17,000 were evacuated and 77,000 sheltered in place.

"I would like to call special attention to CSAC, who provided critical lifesaving information for a chemical incident."

– Dr. Dimitri Kusnezov, DHS Under Secretary for Science and Technology

CARD Enhanced with Robust Features

CSAC made significant strides in enhancing the capabilities of the CARD, releasing versions 17 and 18, which continue to refine and expand the database's robust features. The CARD, a comprehensive and searchable database, plays a crucial role in storing, searching, retrieving, and reporting data related to chemical forensics, focusing on compounds identified as principal hazards, whether released intentionally or by accident. The recent updates not only introduced new high-threat chemicals and expanded the taxonomy for more streamlined searching but also included additional chemical informatics, structures, and routes of synthesis for synthetic opioids, facilitating more effective research and law enforcement interdiction.

Version 17 of the CARD marked a notable enhancement by incorporating an expanded array of chemical informatics and refining the database to include advanced taxonomy features that enhance the search capabilities. This version also saw the transition of the classified version of the CARD to a classified server hosted by DEVCOM CBC, ensuring a secure platform for management of sensitive data. Following these enhancements, version 18 was developed to further optimize search protocols, thereby improving the efficiency of the user experience. This update completed the inclusion of current-phase fentanyl synthetic opioids and expanded the database to include nitazene synthetic routes and chemical informatics.

Looking forward, CSAC plans to further enhance the strategic search routines within the CARD, specifically targeting chemical forensics to ensure that the database remains an valuable tool for stakeholders involved in chemical risk assessment, policy decisions, and emergency response. These ongoing developments in the CARD underscore its pivotal role in national security by providing critical, vetted information that aids in the strategic planning and operational readiness of both national and local response units.



CSAC scientist Alex Dolan demonstrates an "illicit lab" for making illicit drugs or chemicals, which the CARD could be used to predict.

CSAC Advancements in the Detection, Protection, and Decontamination of FGAs

The 2022 DHS CWMD FGA Workshop and follow on activities identified considerable advancements in the fields of detection, protection, and decontamination of FGAs, directly benefiting First Responders and Safety Law Enforcement Teams, among other partners. These efforts enhance national readiness and response capabilities for chemical threats.

In 2024, collaborative research initiatives with DEVCOM CBC, and a complementary effort with Battelle Memorial Institute (BMI) under the S&T Probabilistic Analysis for National Threats Hazards and Risks (PANTHR) program, focused on experimentally determining the by-products from decontaminating FGAs using standard bleach protocols. Sophisticated analytical methods such as Nuclear Magnetic Resonance (NMR), Gas Chromatography–Mass Spectrometry (GC-MS), and Liquid Chromatography (LC)-MS/MS at DEVCOM CBC and NMR, GC/GC-MS, and LC coupled with Triple Quad Mass Spectrometry (LC-TQ) through BMI were employed to characterize



"[I am] super-grateful for the PPE information." He added, "this was one of the best [working group] sessions, and why we are in the room."

– Captain David Moffitt, Paramedic, Phoenix Fire Department

"The PPE presentation was great," and I "would love to see future testing." – Lieutenant Timothy Schnoor, Chicago Police Department

Photo: CBRN scenario-based decontamination training. U.S. Army photo by Sgt. Christopher Neu.

these by-products, providing essential data for safe and efficient cleanup procedures in the event of large-scale incidents.

The involvement of the EPA in reviewing protocols and ensuring quality assurance highlights the rigorous standards maintained in these projects. These collective efforts have bolstered the capability of DHS and associated agencies to effectively manage threats posed by FGAs. The ongoing research, training, and preparedness activities ensure that the response teams are equipped with the latest knowledge and techniques to protect public safety and national security.

In May, CSAC shared their expertise to the CWMD's Chemical Support Branch and its SLTT Working Group at the Federal Law

Enforcement Training Center in Brunswick, Georgia. CSAC led a session on FGAs, including a five-year research study plan. The workshop provided an overview of personal protective equipment (PPE) and the detection, protection, and decontamination methods of FGAs based on a comprehensive science assessment.

Additionally, CSAC has delivered authoritative information on currently available handheld and portable fentanyl detection technologies. This compilation, derived from three comprehensive reports, was meticulously prepared and delivered to customers via the PANTHR team, demonstrating CSAC's commitment to supporting the needs of those at the frontline of chemical risk management.

CSAC Characterized Dermal Threats

CSAC and the U.S. Army Medical Research Institute for Chemical Defense, through the S&T PANTHR program, experimentally analyzed the ability of carfentanil citrate to penetrate the skin barrier using a variety of available solvents (e.g., hand sanitizer, dimethyl sulfoxide, and sterile water). Additionally, proper skin decontamination methods for carfentanil were confirmed.

CSAC Awarded Ammonia Port Preparedness and Emergency Response (AmPPER)

CSAC will lead project AmPPER to understand the current ammonia landscape in the U.S., assemble specific information regarding the expansion of ammonia production and storage needed to meet domestic demands for fertilizer and explosives production, refrigeration and marine bunkering at major U.S. ports; and assess the potential impact from a catastrophic ammonia release at a major U.S. port. CSAC will collaborate with DEVCOM CBC and BMI to evaluate mitigation efforts to be taken at the ports as well as potential expedient response measures recommendations for communities near a potential release site.



Jack Rabbit tests release of ammonia at Dugway Proving Ground, Utah. Through Jack Rabbit, CSAC has demonstrated expertise in the behavior of released industrial chemicals.



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<https://www.dhs.gov/science-and-technology/csac>

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